AEC-NASA TECH BRIEF

Experimental Prediction of Performance by Superconducting Cables

A method employing a "broken superconductor" method of short-sample testing, which makes possible the prediction of the performance of well-cooled, stabilized, superconducting cable coils, has been described (*1*); it yields a field-versus-current curve for a short sample of cable having a length of the superconductor removed from the middle of the sample. Plots are given for the superconductor and copper currents at various magnetic-field strengths; these results are compared with results by the "pulsed heater" method on the same type of cable.

The broken-superconductor method of testing allows separation of the performance characteristics of the superconductor and copper constituents of a stabilized cable. The break in the superconductor is in effect an artificially induced steady-state normal region that forces complete transfer of current into the stabilizing copper in the region of the break. Potential taps are placed at the ends of a superconducting section of cable and, as current through the sample is increased, a potential appears across these taps. The current observed at this point is the maximum superconducting current at a given field, or the "H-I" value.

As current through the sample is increased further, current is shared between the superconductor and the stabilized copper. At sufficiently high current the joule heat generated in the copper is greater than that which can be carried away by nucleate boiling of a helium bath, so that the heat-transfer characteristic changes from nucleate boiling to film boiling, and the temperature difference between the copper and the helium changes from about 0.3°K to about 5°K. This rise in temperature causes all the current to transfer from the superconductor into the copper, and thermal runaway results. The characteristics of the copper are obtained by plotting of these thermal-runaway points as functions of the fields.

At low field, the superconducting current may be greater than the current-carrying capacity of the copper. The broken-superconductor sample is forced into thermal runaway in the region of missing superconductor, since all the current must go through the copper at this point. Therefore, if a sample is understabilized at the test field, only the copper characteristics are obtained by this method, with no indication of the true current-carrying capacity of the superconductor.

A conservative value for the rate of transfer of heat from copper to liquid helium during nucleate boiling is 100 mw/cm^2, which can be used for preliminary design of coils.

Reference:

1. J. R. Purcell and J. M. Brooks, *J. Appl. Phys.* **38**(8), 3109 (July 1967).

Notes:

1. This information may interest those concerned with the manufacture and use of nuclear instrumentation and with cryogenics.
2. Inquiries may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B69-10161

Source: J. R. Purcell
High Energy Physics Division
and J. M. Brooks,
Particle Accelerator Division
(ARG-10215)

(continued overleaf)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439